Study of Light Pollution Affecting Astronomical Observations in the RGB Wavelenghts Together with the Application of Mathematics Models for Light Pollution

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Introduction

This research focuses on studying light pollution in Earth's atmosphere at Princess Chulabhorn Science High School Phetchaburi. The study investigates three main aspects: 1. The impact of light pollution on RGB wavelengths, 2. The patterns and behavior of light pollution, 3. The effects of light pollution on astronomy. The experiment was divided into three distinct phases and conducted during two separate time periods: before 10:30 P.M. (when the dormitory lights were still on) and after 10:30 P.M. (when the dormitory lights were turned off). This approach allowed for a comparative analysis of light pollution under varying lighting conditions.

Method and Result

1. RGB data was collected by taking five photos above the light pollution source, then adjusting the camera angle upward in 20-degree increments until it was directly opposite the source. This angle is referred to as the "Distance Angle from the Light Pollution Source." The data was then analyzed using Python, and the results are shown in Figure 1.

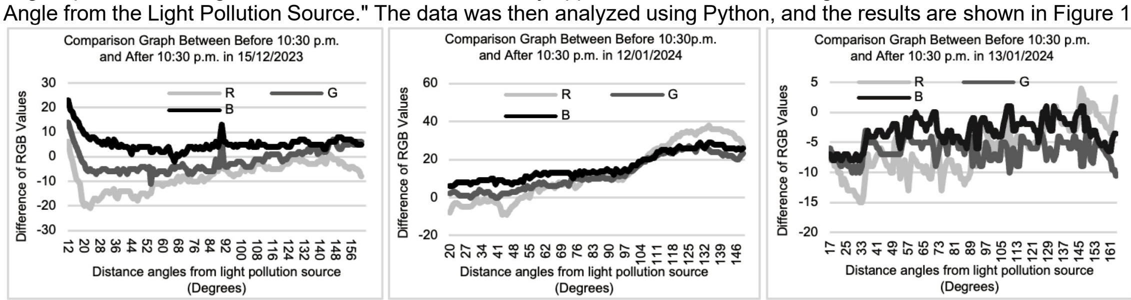

Figure 1. Show the relationship between RGB values and the angle from the city on 15 December 2023 (Left) and 12 (Center) and 13 (Right) January 2024, respectively.

2. The sky magnitude was calculated through the following steps: 1. Images were uploaded to Astrometry.net to identify reference stars and obtain coordinates. 2. Coordinates were imported to convert pixel values to Right Ascension (RA) and Declination (Dec). 3. Photometric analysis was perfomed, including background intensity measurement. 4. Sky subtraction was applied to isolate the star's true intensity. 5. The star's magnitude was determined using Stellarium. 6. The background magnitude was then calculated.

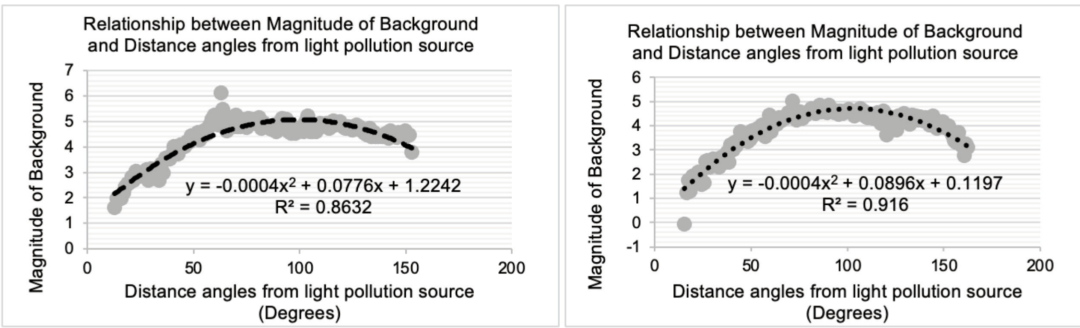

Figure 2. Show the relationship between Magnitude of Background and Distance angles from light pollution source (Degrees) on December 15, 2023 (left) and January 13, 2024 (right).

3. In the mathematical model, the author references “Lamphar, H. (2010), Mathematical Model for the Measurement of Light Pollution”. The model incorporates several key variables, including: The altitude of the observer and the urban area above sea level, the azimuth angle from the observer's position to the observed point, the distance from the observer to the city, the zenith distance of the observer, these variables are used to analyze and quantify the effects of light pollution.

Data analysis and Conclusion

On 15 December 2023, the B (blue) values were higher than R (red) and G (green) values due to light scattering, with blue wavelengths scattering more easily. In contrast, on 12-13 January 2024, the R values were higher as wildfires near the site released aerosols into the atmosphere, increasing scattering of the blue and green wavelengths and leaving more red light. Sky background measurements confirmed this, with lower brightness on 15 December 2023 compared to 13 January 2024. The mathematical model also showed that beyond 90 degrees, the RGB graph curvature was affected by air mass, further highlighting the impact of aerosols on light pollution. And the results are shown in Figure 2.

Reference

Lamphar, H. (2010). Mathematical model for the measurement of light pollution. . 4-6.

Data : https://drive.google.com/drive/folders/1BPobRk5TiBClM8gjYkPTYIArq417S3_w?usp=sharing